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**Original Research Article**

# Role of pre-operative ultrasonography in assessment of technical difficulties during laparoscopic cholecystectomy requiring conversion to open procedure

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## ABSTRACT

**Background:** Cholecystectomy is the most common major abdominal surgery of the biliary tract and the second most common abdominal surgery performed in recent times. Today, laparoscopic cholecystectomy is the treatment of choice for symptomatic gallstones. Ultrasound is a non-invasive, painless investigation that will show stones in the gallbladder with sensitivity and specificity of more than 90%. The study aims at evaluating the accuracy of certain ultrasound parameters to predict a difficult laparoscopic cholecystectomy.
**Methods:** Prospective observational study. The selected patients were explained about the procedures of ultrasonography and laparoscopic cholecystectomy, and about the advantages and disadvantages of laparoscopic cholecystectomy, along with the possibility of conversion to open procedure. Informed consent was taken. General particulars of patients, relevant history & findings on physical examination, laboratory investigations, ultrasonographic features and operative findings were noted in the study proforma. For data analysis, categorical variables were expressed as frequencies and percentages. Sensitivity, specificity and p values were calculated. P value<0.05 was considered to be statistically significant.
**Results:** Significant association was found between all the independent ultrasound parameters and a difficult laparoscopic cholecystectomy. Presence of contracted gall bladder was found to be significantly associated with conversion to open cholecystectomy.
**Conclusions:** It was found that ultrasonography can be a useful tool in predicting a difficult laparoscopic cholecystectomy.

**Keywords:** Gall stones, Ultrasound, Laparoscopy, Difficult

## INTRODUCTION

Laparoscopic cholecystectomy is the treatment of choice for symptomatic gallstones. It offers a cure for gallstones with a minimally invasive procedure, less pain and scarring, and early return to full activity. When important anatomic structures cannot be clearly identified or when no progress is made over a set period of time, a conversion to an open procedure is usually indicated in order to avoid injury to structures like common bile duct or duodenum. Conversion rates are typically less than 10% for both elective and emergency procedures.[1,2]

An ultrasound is the initial investigation of any patient suspected of disease of the biliary tree. It is non-invasive, painless, does not expose the patient to radiation, and can be performed on critically ill patients. It is dependent upon the skills and the experience of the operator. Adjacent organs can frequently be examined at the same time. Ultrasound will show stones in the gallbladder with

sensitivity and specificity of more than 90%. Stones are acoustically dense and reflect the ultrasound waves back to the ultrasonic transducer.

The study aim was to evaluate the accuracy of certain ultrasound parameters to predict a difficult laparoscopic cholecystectomy.

## METHODS

### *Study site*

St. Stephen's Hospital, New Delhi

### *Study population*

Patients of all ages and both sexes, irrespective of comorbidities or duration of disease, with symptomatic gall stones, who get admitted under department of surgery in St Stephen's Hospital, with ultrasonography of whole abdomen done within 1 week prior to the planned laparoscopic cholecystectomy.

### *Exclusion criteria*

Exclusion criteria were 1) patients with common bile duct stones, requiring common bile duct exploration 2) patients with jaundice or abnormal liver function tests 3) patients with pregnancy 4) patients with portal hypertension, cholangitis, known carcinoma gall bladder, acute pancreatitis, known biliary-enteric fistula, known Mirizzi syndrome (types II-V) 5) patients with previous upper abdominal surgery 6) patients with any contraindication to laparoscopic surgery 7) conversion to open procedure due to equipment malfunction.

### *Study design*

Prospective observational study.

### *Sample size*

120 patients were included in the study.

### *Time frame*

January 2018 to May 2019

### *Methodology*

*Preoperative ultrasonography*

This was done after overnight fasting within one week prior to the planned date for surgery in the department of radio-diagnosis of St Stephen's Hospital, New Delhi.

The following criteria were assessed: 1) gall bladder wall thickness-more than 4 mm was considered to be a predictor of a difficult laparoscopic cholecystectomy 2) gall stone mobility– impacted gall stones in gall bladder neck were considered to be a predictor of difficult laparoscopic cholecystectomy 3) gall bladder morphology– contracted gall bladder was considered to be a predictor of a difficult laparoscopic cholecystectomy 4) diameter of common bile duct– more than 6mm was considered to be a predictor of difficult laparoscopic cholecystectomy.

*Intraoperative assessment*

During the laparoscopic cholecystectomy presence of any of the following observations were considered as difficult cholecystectomy: 1) total duration of surgery from creation of pneumoperitoneum to extraction of gall bladder being more than 90 minutes 2) tear of gall bladder during dissection, with spillage of bile and stones, due to difficult and unclear anatomy, and dense pericholecystic adhesions 3) conversion to open procedure because of: difficult dissection (adhesions at Calot's triangle), unclear anatomy (short/dilated cystic duct, unusual positions of cystic artery), to avoid risk of injury to biliary tract or any surrounding viscera, or uncontrollable bleeding.

*Statistical methods*

Descriptive statistics were analyzed with SPSS version 17.0 software. Categorical variables were expressed as frequencies and percentages. The Pearson's chi-square test was used to determine the relationship between two categorical variables.

Sensitivity, specificity and p values were calculated for various ultrasound parameters as predictors for difficult laparoscopic cholecystectomy. P value<0.05 was considered statistically significant.

## RESULTS

Out of the 120 patients, 91 were females and 29 were males. Maximum incidence of gall stone disease was seen in the age group of 31-40 years in both sexes. Highest number of difficult laparoscopic cholecystectomies were encountered in the age group of 51-60 years (Figure 1). Total 8 patients had gall bladder wall thickness>4mm of which 6 patients (75%) had a difficult laparoscopic surgery (Table 1).

**Table 1: Correlation of gall bladder wall thickness and difficulty in laparoscopic surgery.**

| Operative inference | Gall bladder wall thickness | | | |
|---|---|---|---|---|
| | <4mm | | >4mm | |
| | F | % | F | % |
| **Easy** | 82 | 73.2 | 2 | 25 |
| **Difficult** | 30 | 26.8 | 6 | 75 |
| **Total** | 112 | 100 | 8 | 100 |

F=frequency

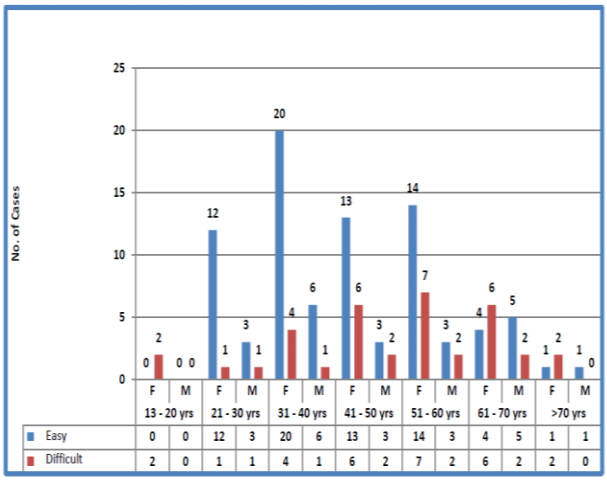


**Figure 1: Age-wise distribution of difficulty of laparoscopic cholecystectomy.**

Out of 8 patients with gall bladder wall thickness>4mm, 2 patients (25%) had to be converted to open (Table 2).

**Table 2: Correlation of gall bladder wall thickness and conversion to open cholecystectomy.**

| Conversion to open cholecystectomy | Gall bladder wall thickness | | | |
|---|---|---|---|---|
| | <4mm | | >4mm | |
| | F | % | F | % |
| **No** | 102 | 91.1 | 6 | 25 |
| **Yes** | 10 | 8.9 | 2 | 75 |
| **Total** | 112 | 100 | 8 | 100 |

F=frequency

Total 13 patients had impacted calculi at gall bladder neck, of whom 11 patients (84.7%) had a difficult surgery (Table 3).

**Table 3: Correlation of impacted stone at gall bladder neck and difficulty in laparoscopic surgery.**

| Operative inference | Mobility of stone | | | |
|---|---|---|---|---|
| | Not impacted | | Impacted | |
| | F | % | F | % |
| **Easy** | 82 | 76.6 | 2 | 15.3 |
| **Difficult** | 25 | 23.4 | 11 | 84.7 |
| **Total** | 107 | 100 | 13 | 100 |

F=frequency

**Table 4: Correlation of impacted stone at gall bladder neck and difficulty in laparoscopic surgery.**

| Conversion to open cholecystectomy | Impacted stone at gall bladder neck | | | |
|---|---|---|---|---|
| | Absent | | Present | |
| | F | % | F | % |
| **No** | 98 | 91.5 | 10 | 76.9 |
| **Yes** | 9 | 8.5 | 3 | 23.1 |
| **Total** | 107 | 100 | 13 | 100 |

F=frequency

Out of 13 patients with impacted calculi at gall bladder neck, 3 patients (23.1%) had to be converted to open (Table 4).

Total 9 patients were found to have contracted gall bladder of which 8 patients (88.8%) had a difficult surgery (Table 5).

**Table 5: Correlation of morphology of gall bladder (distended/contracted) and difficulty in laparoscopic surgery.**

| Operative inference | Gall bladder morphology | | | |
|---|---|---|---|---|
| | Distended | | Contracted | |
| | F | % | F | % |
| **Easy** | 83 | 74.8 | 1 | 11.2 |
| **Difficult** | 28 | 25.2 | 8 | 88.8 |
| **Total** | 111 | 100 | 9 | 100 |

F=frequency

Out of 9 patients with contracted gall bladder, 4 patients (44.5%) had to be converted to open cholecystectomy (Table 6).

**Table 6: Correlation of morphology of gall bladder (distended/contracted) and conversion to open cholecystectomy.**

| Conversion to open cholecystectomy | Gall bladder morphology | | | |
|---|---|---|---|---|
| | Distended | | Contracted | |
| | F | % | F | % |
| **No** | 103 | 92.7 | 5 | 55.5 |
| **Yes** | 8 | 7.3 | 4 | 44.5 |
| **Total** | 111 | 100 | 9 | 100 |

F=frequency

Total 10 patients were found to have CBD diameter>6mm of whom 7 patients (70%) had a difficult surgery (Table 7).

**Table 7: Correlation of diameter of common bile duct and difficulty in laparoscopic surgery.**

| Operative inference | Common bile duct diameter | | | |
|---|---|---|---|---|
| | <6mm | | >6mm | |
| | F | % | F | % |
| **Easy** | 81 | 73.6 | 3 | 30 |
| **Difficult** | 29 | 26.7 | 7 | 70 |
| **Total** | 110 | 100 | 10 | 100 |

F=frequency

Out of 10 patients with CBD diameter>6mm, only 2 patients (20%) required conversion to open (Table 8).

Total 120 patients were operated upon, of whom 36 (30%) of them took more than 90 minutes from creation of pneumoperitoneum to extraction of gall bladder specimen (due to dense pericholecystic adhesions,

unclear anatomy or conversion to open procedure) and have been considered as difficult (Table 9).

**Table 8: Correlation of diameter of common bile duct and conversion to open cholecystectomy.**

| Conversion to open cholecystectomy | Common bile duct diameter | | | |
|---|---|---|---|---|
| | <6mm | | >6mm | |
| | F | % | F | % |
| No | 100 | 90.9 | 8 | 80 |
| Yes | 10 | 9.1 | 2 | 20 |
| Total | 110 | 100 | 10 | 100 |

F=frequency

**Table 9: Relation between duration of surgery and operative difficulty.**

| Duration of surgery | Operative inference | | | |
|---|---|---|---|---|
| | Easy | | Difficult | |
| | F | % | F | % |
| >90 mins | 0 | 0 | 36 | 100 |
| <90 mins | 84 | 100 | 0 | 0 |
| Total | 84 | 100 | 36 | 100 |

F=frequency

All the 3 surgeries where tear of gall bladder occurred have been considered to be difficult. The remaining 33 cases have been considered difficult due to other reasons like dense pericholecystic adhesions, unclear anatomy or conversion to open procedure (Table 10).

**Table 10: Relation between tear of gall bladder with spillage of bile and calculi, and operative difficulty.**

| Occurrence of tear of gall bladder | Operative inference | | | |
|---|---|---|---|---|
| | Easy | | Difficult | |
| | F | % | F | % |
| Yes | 0 | 0 | 3 | 8.3 |
| No | 84 | 100 | 33 | 91.7 |
| Total | 84 | 100 | 36 | 100 |

F=frequency

**Table 11: Relation between conversion to open and operative difficulty.**

| Conversion to open cholecystectomy | Operative inference | | | |
|---|---|---|---|---|
| | Easy | | Difficult | |
| | F | % | F | % |
| Yes | 0 | 0 | 12 | 33.3 |
| No | 84 | 100 | 24 | 66.7 |
| Total | 84 | 100 | 36 | 100 |

F=frequency

All cases requiring conversion to open have been considered to be difficult. Of the 120 cases, a total of 36 cases were considered to be difficult. 12 of these 36 cases had to be converted to open. The remaining 24 cases had either prolonged operating time (>90 minutes) or tear of gall bladder leading to spillage of bile and calculi, but not did not required conversion to open procedure. This shows a laparoscopy to open conversion rate of 10% (Table 11).

Total 12 patients required laparoscopic cholecystectomy to be converted to open cholecystectomy.

Among these 12 patients, 2 of them had a gall bladder wall thickness>4mm, while rest 10 had wall thickness<4mm.

Total 2 patients of these 12 patients had impacted calculi at gall bladder neck, while the remaining 10 did not. Of these 12 patients, 4 patients had contracted gall bladder and the other 8 had a distended gall bladder. Common bile duct diameter was>6mm in 2 patients, and<6mm in the other 10 patients.

**Table 12: Distribution of preoperative ultrasound findings among cases that were converted to open cholecystectomy.**

| Ultrasound findings | | Number of patients |
|---|---|---|
| Gall bladder wall thickness | >4mm | 2 |
| | <4mm | 10 |
| Impacted calculi at gall bladder neck | Present | 2 |
| | Absent | 10 |
| Gall bladder morphology | Contracted | 4 |
| | Distended | 8 |
| Common bile duct diameter | >6mm | 2 |
| | <6mm | 10 |

## DISCUSSION

It was found that out of 8 patients with gall bladder wall thickness>4mm, 2 patients (25%) had an easy laparoscopic surgery while the remaining 6 patients (75%) had a difficult surgery. In the rest 112 patients with normal gall bladder wall thickness, 30 patients (26.8%) had a difficult surgery. p value was found to be 0.008, which is statistically significant.

Of these 8 patients, 2 of them (25%) had to be converted to open and of the remaining 112 patients, 10 patients (8.9%) had to be converted to open cholecystectomy. p value was found to be 0.183, which is not statistically significant.

It was found that 13 patients had impacted calculi at gall bladder neck, of which 11 patients (84.7%) had a difficult surgery. Out of the remaining 107 patients without an impacted calculus, 25 patients (23.4%) had a difficult surgery. P value was found to be<0.001, which is statistically significant.

In these 107 patients without impacted calculi at gall bladder neck, only 9 patients (8.5%) had to be converted

to open cholecystectomy. Out of the other 13 patients, 3 patients (23.1%) had to be converted to open. p value was found to be 0.123, which is not statistically significant.

Total 9 patients were found to have contracted gall bladder of which 8 patients (88.8%) had a difficult surgery. Among the remaining 111 patients with a distended gall, 28 patients (25.2%) had a difficult surgery. P value was found to be<0.001, which is statistically significant.

Out of the 111 patients with distended gall bladder, 8 patients (7.3%) had to be converted to open cholecystectomy. Out of the 9 patients with contracted gall bladder, 4 patients (44.5%) had to be converted to open cholecystectomy. P value was found to be 0.006, which is statistically significant.

Here, 10 patients were found to have CBD diameter>6mm of whom 7 patients (70.0%) had a difficult surgery. Of the remaining 110 patients with CBD diameter<6mm, 29 patients (26.7%) had a difficult surgery. P value was found to be 0.006, which is statistically significant.

Out of 110 patients with CBD diameter<6mm, 10 patients (9.1%) had to be converted to open. Out of 10 patients with CBD diameter>6mm, 2 patients (20.0%) required conversion. P value was found to be 0.262, which is not statistically significant.

Of all the four parameters studied to predict a difficult laparoscopic cholecystectomy, namely, gall bladder wall thickness>4mm, presence of impacted calculi at gall bladder neck, presence of contracted gall bladder and common bile duct diameter>6mm, strongest correlation was shown by presence of impacted calculus at gall bladder neck (p value<0.001) and contracted gall bladder (p value<0.001), both of which were statistically significant.

Of all the four parameters studied to predict conversion to open cholecystectomy, statistically significant correlation was shown by presence contracted gall bladder (p value 0.006). The other 3 parameters were not statistically significant in predicting chances of conversion to open.

The finding that only 12 cases out of the 36 difficult cases had to be converted to open cholecystectomy shows that all difficult laparoscopic cholecystectomies do not need to be converted to open cholecystectomy. The decision to convert is a highly individual one, and is best left to the discretion of the sufficiently skilled surgeon.

Several studies have been done previously to correlate preoperative ultrasound findings to predict a difficult laparoscopic cholecystectomy.

A study by Sharma et al had taken into consideration sonographic parameters like size of gall bladder, wall thickness, distance between hepaticoduodenal ligament and Hartmann's pouch and the size of stone were and difficulties in terms of adhesions around gall bladder, anatomy of Calot's triangle and difficulty in peeling off gall bladder from the bed and retrieval were analyzed.

It was concluded that preoperative sonographic signs can predict the difficulty in laparoscopic cholecystectomy.[3]

In a study by Lal et al a preoperative ultrasound was performed just prior to surgery, and 4 ultrasonographic parameters were analyzed, namely gallbladder wall thickness, contracted gallbladder, impaction of gallstones at the neck of the gallbladder, and common bile duct stones. It was concluded that preoperative ultrasonography is a good predictor of difficulty in laparoscopic cholecystectomy in the majority of cases and should be used as a screening procedure.[4]

A study by Vivek et al showed that a distended gall bladder or a gall bladder filled with stones, presence of inflammation around the gall bladder leads to problems of grasping, thus making the laparoscopic procedure difficult. Calot's triangle difficulty was associated with the sonographic parameters like contracted gall bladder, presence of peri-pancreatic fluid, presence of multiple stones, presence of cirrhosis on ultrasound, non visualisation of the gall bladder, inflamed gall bladder and presence of ductal anomalies.[5]

Ercan et al concluded in a study that significant predictors of conversion to open cholecystectomy included preoperative ultrasound findings of a thickened gallbladder wall and dilated common bile duct.[6]

Gabriel et al found that ultrasonography findings of multiple calculi and gall bladder wall thickness of more than 3 mm, and intraoperative gall bladder perforation with spillage of its contents in abdominal cavity and dense adhesions with difficult anatomy resulted in higher conversion rate.[7]

A study by Nidoni et al revealed that sonographic findings of gall bladder wall thickness of>3mm and pericholecystic collection were statistically significant for predicting the difficult laparoscopic cholecystectomy and its conversion.[8]

Study of Dhanke et al showed that gallbladder wall thickening, impacted stone, and pericholecystic collection are significant predictors of difficult laparoscopic cholecystectomy.[9]

Chand et al found that gallbladder wall thickness more than 4 mm, stone impacted at the neck of gallbladder, contracted gallbladder and common bile duct size more than 6 mm in preoperative ultrasonography was a

predictor of difficult laparoscopic cholecystectomy that requires conversion to open procedure.[10]

## CONCLUSION

It was found that ultrasonography can be a useful tool in predicting a difficult laparoscopic cholecystectomy. Significant association was found between all the independent ultrasound parameters and a difficult laparoscopic cholecystectomy. Apart from presence of contracted gall bladder, no significant association was found between the other ultrasound parameters and conversion to open cholecystectomy.

Therefore, at the end of this study, it can be recommended that preoperative ultrasound should be used as a tool to predict a difficult laparoscopic cholecystectomy. It will help in preoperative counseling of patients and also explaining about chances of conversion to open procedure. It will help the surgeon to be mentally prepared when a difficult surgery is anticipated. But it should also be kept in mind that preoperative ultrasound is not the ideal modality to predict chances of conversion to open cholecystectomy and all difficult laparoscopic cholecystectomies do not need to be converted to open cholecystectomy.

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